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Analysis of N and P-Type Semiconductor Materials in Electricity

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ABSTRACT
In everyday life, there are several types of electrical materials, including conductors, insulators and semiconductors. Apart from materials that can conduct and withstand electric current, semi-conductor materials are also needed, namely electrically conducting materials that are between electrical conductors and electrical insulators. This material functions as an insulator at low temperatures, and is a conductor at quite high temperatures, but cannot conduct heat like conductor materials. This type of semi-conductor material is also not very dangerous, but you also need to be careful when using it. The most frequently used semi-conductor materials are carbon, silicon and germanium.

Keywords* : *Semiconductor, Type N, Type P

INTRODUCTION

In everyday life, there are several types of electrical materials among conductors, insulators, and semiconductors. Conductor materials are materials that can conduct electric current, insulator materials are materials that cannot conduct / inhibit electric current. In addition to conducting materials and inhibiting electric current, semiconductor materials are also needed, namely electrical conductivity materials that are between electrical conductors and electrical insulators. This material is an insulator at low temperatures, and is a conductor at a high enough temperature, but cannot conduct heat as well as conducting materials. This type of semi-conductor material is also not too dangerous, but also needs to be careful in its use. The most commonly used semiconductor materials are Carbon, Silicon, and Germanium.

LITERATURE REVIEW

Semiconductor Material

Semiconductor materials are materials that are semiconductor because the energy gap formed by the structure of this material is smaller than the energy gap of insulating materials but larger than the energy gap of conducting materials, thus allowing electrons to move from one constituent atom to another with certain treatments of the material (applying voltage, temperature changes and so on). Therefore semiconductors can be half-conducting.

Types of Semiconductor Materials

A semiconducting material consists of 4 valence electrons. The types of semiconductor materials commonly used are carbon, germanium, and silicon. Carbon is a chemical element that has symbol C and atomic number 6 on the periodic table. This element belongs to the group of non-metals and has a valence of 4, which means that there are 4 electrons forming covalent bonds.

1. Germanium is a chemical element with symbol Ge and atomic number 32. Germanium is shiny, hard but brittle, grayish-white in color and similar to silicone. Germanium is a metalloid in the carbon group that naturally reacts and forms complexes with oxygen

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in nature.

2. Silicon is a chemical element in the periodic table that has symbol Si and atomic number 14. The compounds formed are paramagnetic. This chemical element, also referred to as sand, was discovered by Jöns Jakob Berzelius. Silicon is a tetravalence metalloid, less reactive than carbon (a nonmetal element just above it on the periodic table, but more reactive than germanium, a metalloid just below it on the periodic table.

METHODS

The research method used in this study consists of literature studies and descriptive studies. The objects used in this study are Type N and Type P Semiconductor Materials.

RESULTS AND DISCUSSION

Differences between N-type and P-type in semiconductor materials

Type N Semiconductor Material

N-type extrinsic semiconductors are created when group V elements such as phosphorus, antimony, bismuth, etc., are processed into complete semiconductor crystals. It is so named because doping these elements will produce an extra electron in the valence shell of the atom.

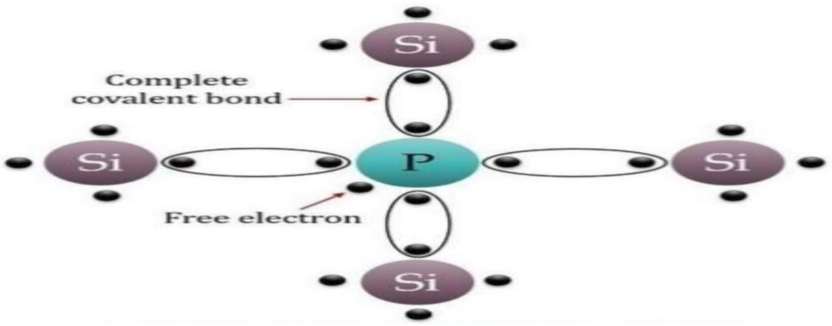

Figure 1. Forming of N-type semiconductors

Phosphorus consists of 5 electrons in its valence shell. When doped with pure silicon with 4 electrons in the valence shell, it forms four covalent bonds. This results in the presence of unbound electrons that remain free to move into the conduction band. These electrons are considered free electrons and their advancement increases the conductivity of the material.

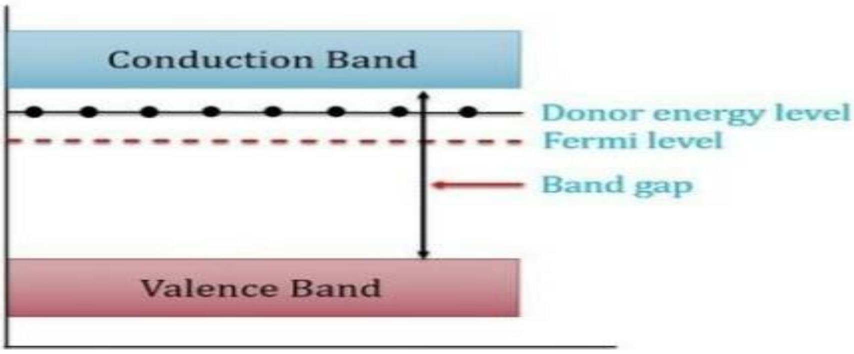

Figure 2. N Type Semi Conductor Energy Band Diagram

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Here, from the image it is clear that the presence of the Fermi level is near the conduction band. We can recognize that there is a small energy difference between the energy level of the donor and the conduction band. So, less energy is needed for electrons to reach the conduction band.

P Type Semiconductor Material

P-type semiconductors are produced by doping intrinsic semiconductors with electron acceptor elements during manufacture. The term p-type refers to the positive charge of a hole. In contrast to n-type semiconductors, p-type semiconductors have a greater concentration of holes than the concentration of electrons. In p-type semiconductors, the cavity is the majority carrier and electrons are the minority carrier. A typical p-type dopant for silicon is aluminum, boron, or gallium. For p-type semiconductors, the Fermi level is below the intrinsic Fermi level and is located closer to the valence band than the conduction band.

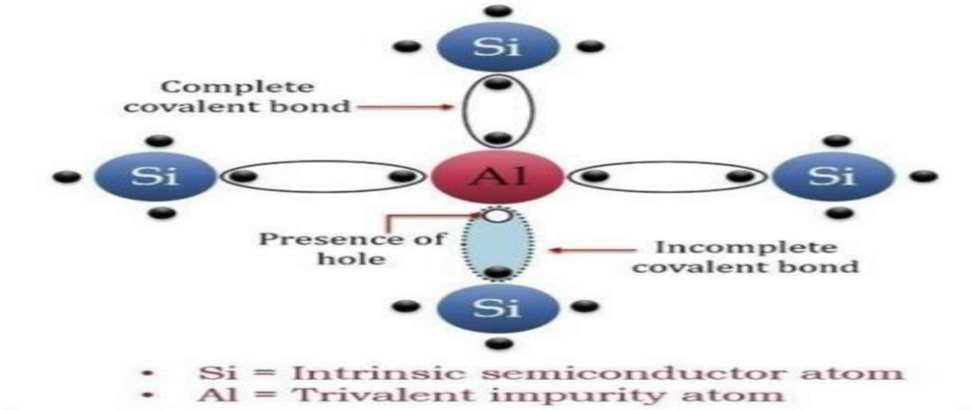

Figure 3. P-Type Semiconductor Formation

An aluminum atom contains three electrons in its valence shell. In addition, silicon has a total of four electrons in its valence shell. So, three valence electrons of an aluminum atom form a covalent bond with three silicon electrons. Nevertheless, in this case, an electron vacuum (or hole) appears. This hole translation is largely responsible for conduction in p-type semiconductors. Therefore, in this case, the charge carrier is a hole, not an electron.

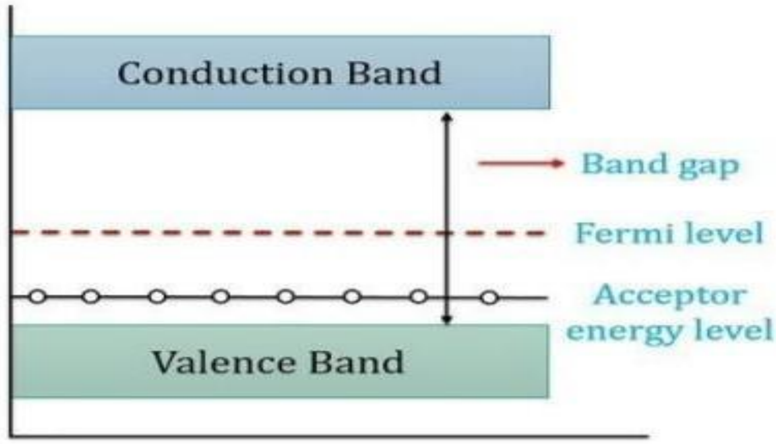

Figure 4. P-type Semiconductor Energy Level Diagram

Here, we can recognize that the Fermi level is near the valence band. It is clear from the figure above that there is a small energy difference between the valence band and the acceptor energy level. Therefore, electrons easily move to the acceptor's energy level, resulting in an electron vacuum. Therefore, holes are made in the valence band.

CONCLUSION

Based on the data above, it can be concluded that type P and Type N semiconductors are extrinsic semiconductors. However, the main difference between the two is that P-type semiconductors are obtained by adding trivalent impurities such as aluminum in pure semiconductors, and these semiconductors are called positive semiconductors because of the presence of additional holes. While N-type semiconductors are obtained by adding pentavalent impurities such as phosphorus in pure semiconductors, and this type of semiconductor is referred to as negative semiconductors because of the presence of extra electrons.

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